~~We claim:~~

~~1. An actuator comprising:~~

~~a housing defining an inlet port;~~

~~a piston disposed within the housing;~~

~~a return spring disposed within the housing and configured to apply a first biasing force to the piston to move the piston toward a spring return position; and~~

~~an elastically deformable element;~~

~~wherein a first fluid pressure applied to the inlet port moves the piston against the first biasing force of the return spring to a first actuated position in which the piston indirectly engages a stop portion of the actuator housing through at least the elastically deformable element; and~~

~~wherein a second fluid pressure, greater than the first fluid pressure, applied to the inlet port moves the piston against a second biasing force of the elastically deformable element to compress the elastically deformable element and to move the piston to a second actuated position beyond the first actuated position.~~

~~2. The actuator of claim 1, wherein the elastically deformable element comprises at least one Belleville spring washer.~~

~~3. The actuator of any of claims 1 and 2, wherein the elastically deformable element has a spring rate at least about 10 times a spring rate of the return spring.~~

~~4. The actuator of any of claims 1-3, wherein the elastically deformable element has a spring rate up to about 100 times a spring rate of the return spring.~~

~~5. The actuator of any of claims 1-4, wherein the second fluid pressure is up to about two times the first fluid pressure.~~

~~6. The actuator of any of claims 1-5, wherein movement of the piston from the spring return position to the first actuated position comprises axial movement of the piston of a first distance, and movement of the piston from the first actuated position to the second actuated position~~

~~comprises axial movement of the piston of a second distance less than about 20% of the first distance.~~

~~7. The actuator of any of claims 1-5, wherein movement of the piston from the spring return position to the first actuated position comprises axial movement of the piston of a first distance, and movement of the piston from the first actuated position to the second actuated position comprises axial movement of the piston of a second distance at least about five times the first distance.~~

~~8. The actuator of any of claims 1-7, wherein the elastically deformable element has a spring rate that is substantially constant between the first and second actuated positions of the piston, such that incremental increases in fluid pressure between the first fluid pressure and the second fluid pressure cause proportional incremental movement of the piston between the first actuated position and the second actuated position.~~

~~9. The actuator of any of claims 1-8, wherein the piston comprises a stem portion extending into an actuator inlet port of the actuator housing, and a disk portion extending radially outward from the stem portion.~~

~~10. The actuator of claim 9, wherein the stop portion is defined by an internal surface of the actuator inlet port, and the elastically deformable element is disposed between the internal surface of the actuator inlet port and an end portion of the piston stem portion.~~

~~11. The actuator of claim 9, wherein the stop portion is defined by an end face of the actuator inlet port, and the elastically deformable element is disposed between the end face of the actuator inlet portion and an inner radial portion of the disk portion.~~

~~12. The actuator of any of claims 1-9, wherein the piston is a first piston, and wherein the actuator further comprises a second piston disposed within the housing, wherein the first fluid pressure applied to the inlet port moves the second piston against the first biasing force of the return spring to a first actuated position of the second piston.~~

13. The actuator of claim 12, wherein the stop portion is defined by an end face of an actuator inlet port, and the elastically deformable element is disposed between the first piston and the second piston.

14. The actuator of claim 12, wherein the actuator housing includes a partition plate disposed between the first piston and the second piston, wherein the stop portion is defined by the partition plate, and the elastically deformable element is disposed between the first piston and the partition plate.

15. The actuator of any of claims 1-9, wherein the piston comprises an output shaft extending through an output port in the actuator housing to apply an output force to a valve when the valve is assembled with the actuator.

16. The actuator of claim 15, wherein the stop portion is defined by the output port, and the elastically deformable element is disposed between the output shaft and the output port.

17. The actuator of any of claims 1-16, wherein the elastically deformable element is disposed between the piston and the stop portion of the actuator housing.

18. The actuator of any of claims 1, 3-9, 12, and 15, wherein the elastically deformable element is integral with the piston.

19. The actuator of any of claims 1, 3-9, 12, and 15, wherein the elastically deformable element is integral with the stop portion of the actuator housing.

20. An actuated valve assembly comprising:

a valve including a valve body defining a flow path and a valve element axially movable to selectively control fluid flow through the valve flow path;

the actuator of any of claims 1-19, wherein the actuator is assembled with the valve and the piston is operatively connected with the valve element for axial movement of the valve element.

~~21. The actuated valve assembly of claim 20, wherein when the actuator is in the spring return position the valve element is in a closed position against a valve seat in the valve body.~~

~~22. The actuated valve assembly of claim 20, wherein when the actuator is in the first actuated position, the valve element is in a partial flow position.~~

~~23. The actuated valve assembly of claim 22, wherein when the actuator is in the second actuated position, the valve element is in a full flow position having a full flow coefficient greater than a partial flow coefficient in the partial flow position.~~

~~24. The actuated valve assembly of claim 23, wherein the full flow coefficient is up to about 10% greater than the partial flow coefficient.~~

We claim:

1. An actuator comprising:

a housing defining an inlet port;

a piston disposed within the housing;

a return spring disposed within the housing and configured to apply a first biasing force to the piston to move the piston toward a spring return position; and

an elastically deformable element;

wherein a first fluid pressure applied to the inlet port moves the piston against the first biasing force of the return spring, without compression of the elastically deformable element, to a first actuated position in which the piston indirectly engages a stop portion of the housing through at least the elastically deformable element; and

wherein a second fluid pressure, greater than the first fluid pressure, applied to the inlet port moves the piston against a second biasing force of the elastically deformable element to compress the elastically deformable element and to move the piston to a second actuated position beyond the first actuated position;

wherein the elastically deformable element has a spring rate at least about 10 times a spring rate of the return spring; and

wherein movement of the piston from the spring return position to the first actuated position comprises axial movement of the piston of a first distance, and movement of the piston from the first actuated position to the second actuated position comprises axial movement of the piston of a second distance less than about 20% of the first distance.

2. The actuator of claim 1, wherein the elastically deformable element comprises at least one Belleville spring washer.

3. The actuator of any of claims 1 and 2, wherein the elastically deformable element has a spring rate up to about 100 times a spring rate of the return spring.

4. The actuator of any of claims 1-3, wherein the second fluid pressure is up to about two times the first fluid pressure.

5. The actuator of any of claims 1-4, wherein the elastically deformable element has a spring rate that provides for proportional incremental movement of the piston between the first actuated position and the second actuated position in response to incremental increases in fluid pressure between the first fluid pressure and the second fluid pressure.

6. The actuator of any of claims 1-5, wherein the piston comprises a stem portion extending into the inlet port of the housing, and a disk portion extending radially outward from the stem portion.

7. The actuator of any of claims 1-6, wherein the piston comprises an output shaft extending through an output port in the housing to apply an output force to a valve when the valve is assembled with the actuator.

8. The actuator of any of claims 1-7, wherein the piston is a first piston, and wherein the actuator further comprises a second piston disposed within the housing, wherein the first fluid pressure applied to the inlet port moves the second piston against the first biasing force of the return spring to a first actuated position of the second piston.

9. The actuator of any of claims 1-8, wherein the elastically deformable element is disposed between the piston and the stop portion of the housing.

10. The actuator of any of claims 1-8, wherein the elastically deformable element is integral with the piston.

11. The actuator of any of claims 1-8, wherein the elastically deformable element is integral with the stop portion of the housing.

12. An actuated valve assembly comprising:

a valve including a valve body defining a flow path and a valve element axially movable to selectively control fluid flow through the valve flow path;

the actuator of any of claims 1-11, wherein the actuator is assembled with the valve and the piston is operatively connected with the valve element for axial movement of the valve element.

13. The actuated valve assembly of claim 12, wherein when the actuator is in the spring return position the valve element is in a closed position against a valve seat in the valve body.

14. The actuated valve assembly of any of claims 12 and 13, wherein when the actuator is in the first actuated position, the valve element is in a partial flow position.

15. The actuated valve assembly of claim 14, wherein when the actuator is in the second actuated position, the valve element is in a full flow position having a full flow coefficient greater than a partial flow coefficient in the partial flow position.

16. The actuated valve assembly of claim 15, wherein the full flow coefficient is up to about 10% greater than the partial flow coefficient.

17. An actuator comprising:

a housing defining an inlet port;

a piston disposed within the housing;

a return spring disposed within the housing and configured to apply a first biasing force to the piston to move the piston toward a spring return position; and

an elastically deformable element;

wherein a first fluid pressure applied to the inlet port moves the piston against the first biasing force of the return spring to a first actuated position in which the piston indirectly engages a stop portion of the housing through at least the elastically deformable element; and

wherein a second fluid pressure, greater than the first fluid pressure, applied to the inlet port moves the piston against a second biasing force of the elastically deformable element to compress the elastically deformable element and to move the piston to a second actuated position beyond the first actuated position;

wherein the piston comprises a stem portion extending into the inlet port of the housing, and a disk portion extending radially outward from the stem portion; and

wherein the stop portion is defined by an internal surface of the actuator inlet port, and the elastically deformable element is disposed between the internal surface of the inlet port and an end portion of the stem portion.

18. An actuator comprising:

a housing defining an inlet port;

a piston disposed within the housing;

a return spring disposed within the housing and configured to apply a first biasing force to the piston to move the piston toward a spring return position; and

an elastically deformable element;

wherein a first fluid pressure applied to the inlet port moves the piston against the first biasing force of the return spring to a first actuated position in which the piston indirectly engages a stop portion of the housing through at least the elastically deformable element; and

wherein a second fluid pressure, greater than the first fluid pressure, applied to the inlet port moves the piston against a second biasing force of the elastically deformable element to compress the elastically deformable element and to move the piston to a second actuated position beyond the first actuated position;

wherein the piston comprises a stem portion extending into the inlet port of the housing, and a disk portion extending radially outward from the stem portion; and

wherein the stop portion is defined by an end face of the inlet port, and the elastically deformable element is disposed between the end face of the inlet portion and an inner radial portion of the disk portion.

19. An actuator comprising:

a housing defining an inlet port;

a piston disposed within the housing;

a return spring disposed within the housing and configured to apply a first biasing force to the piston to move the piston toward a spring return position; and

an elastically deformable element;

wherein a first fluid pressure applied to the inlet port moves the piston against the first biasing force of the return spring to a first actuated position in which the piston indirectly engages a stop portion of the housing through at least the elastically deformable element; and

wherein a second fluid pressure, greater than the first fluid pressure, applied to the inlet port moves the piston against a second biasing force of the elastically deformable element to compress the elastically deformable element and to move the piston to a second actuated position beyond the first actuated position;

wherein the piston is a first piston, and wherein the actuator further comprises a second piston disposed within the housing, wherein the first fluid pressure applied to the inlet port moves the second piston against the first biasing force of the return spring to a first actuated position of the second piston; and

wherein the stop portion is defined by an end face of the inlet port, and the elastically deformable element is disposed between the first piston and the second piston.

20. An actuator comprising:

a housing defining an inlet port;

a piston disposed within the housing;

a return spring disposed within the housing and configured to apply a first biasing force to the piston to move the piston toward a spring return position; and

an elastically deformable element;

wherein a first fluid pressure applied to the inlet port moves the piston against the first biasing force of the return spring to a first actuated position in which the piston indirectly engages a stop portion of the housing through at least the elastically deformable element; and

wherein a second fluid pressure, greater than the first fluid pressure, applied to the inlet port moves the piston against a second biasing force of the elastically deformable element to compress the elastically deformable element and to move the piston to a second actuated position beyond the first actuated position;

wherein the piston is a first piston, and wherein the actuator further comprises a second piston disposed within the housing, wherein the first fluid pressure applied to the inlet port moves the second piston against the first biasing force of the return spring to a first actuated position of the second piston; and

wherein the housing includes a partition plate disposed between the first piston and the second piston, wherein the stop portion is defined by the partition plate, and the elastically deformable element is disposed between the first piston and the partition plate.

21. An actuator comprising:

a housing defining an inlet port;

a piston disposed within the housing;

a return spring disposed within the housing and configured to apply a first biasing force to the piston to move the piston toward a spring return position; and

an elastically deformable element;

wherein a first fluid pressure applied to the inlet port moves the piston against the first biasing force of the return spring to a first actuated position in which the piston indirectly engages a stop portion of the housing through at least the elastically deformable element; and

wherein a second fluid pressure, greater than the first fluid pressure, applied to the inlet port moves the piston against a second biasing force of the elastically deformable element to compress the elastically deformable element and to move the piston to a second actuated position beyond the first actuated position;

wherein the piston comprises an output shaft extending through an output port in the housing and outward of the housing, with an external portion of the output shaft being configured to apply an output force to a valve when the valve is assembled with the actuator;

wherein the stop portion is defined by an exterior surface of the actuator housing surrounding the output port, and the elastically deformable element is disposed between the external portion of the output shaft and the exterior surface of the actuator housing.

22. The actuator of claim 21, wherein the elastically deformable element has a spring rate at least about 10 times a spring rate of the return spring.

23. The actuator of any of claims 21 and 22, wherein movement of the piston from the spring return position to the first actuated position comprises axial movement of the piston of a first distance, and movement of the piston from the first actuated position to the second actuated

position comprises axial movement of the piston of a second distance less than about 20% of the first distance.